

MIGRATION OF JUVENILE HERRING (*CLUPEA HARENGUS*) AND SPRAT (*SPRATTUS SPRATTUS*) BETWEEN THE NORTH SEA AND THE SCHELDE ESTUARY PROVED BY STABLE C AND N ISOTOPES

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The temporal changes in abundance of juvenile herring (*Clupea harengus*, Linnaeus, 1758) and sprat [*Sprattus sprattus*, Linnaeus, 1758] in the Schelde Estuary were examined by means of stable isotopes. Juvenile herring and sprat typically overwinter in the estuary. Herring exhibits a second, smaller density peak in the summer. A similar density peak for sprat is not observed. The temporal use of the estuary by clupeoid fish has previously been attributed to seasonal migrations of juveniles between the North Sea and the estuary. Using stable isotopes of carbon and nitrogen we have tried to elucidate these migration patterns. Herring and sprat were sampled between May 2000 and April 2001. Samples were taken every month in the cooling water of the Doel Nuclear Power Plant (in the brackish part of the estuary) and the Borssele Nuclear Power Plant (at the mouth of the estuary).

Using cluster analysis on the $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of individual muscle tissue, fish which recently immigrated from the North Sea (marine group with typical marine isotope values) could be distinguished from individuals which had resided in the estuary (estuarine group with typical estuarine isotope values). The analysis showed that herring and sprat had very similar migration dynamics in the Schelde Estuary, characterized by immigration and emigration almost throughout the year and an intensive migration activity during the winter. Net upstream immigration (i.e. the majority of fish enter the estuary) started in September and peaked in November. During December immigration remained high but had already decreased, which probably explains lower fish densities recorded at Doel. Although the density of herring and sprat further declined in February and March, net seaward emigration *sensu strictu* (i.e. the majority of the fish leave the estuary) was not demonstrated using the stable isotope technique. During the winter larger proportions of individuals with a typical marine isotope signature at Doel were not only associated with migration but also with a slower tissue turnover rate.